Report for 2004TN14B: In-Field Comparison of Drip Distribution Dosed with Septic Tank Effluent vs. Secondary Quality Effluent

- Other Publications:
  - Buchanan, J R, 2005, Comparison of primary and secondary treated wastewater in drip dispersal, Tennessee Section ASAE Annual Meeting, Crossville, TN, June 16, 2005.
  - Buchanan, J R, J T Watson, 2005, Subsurface wastewater drip irrigation design workshop, Tennessee Onsite Wastewater Association Annual Meeting, Spring Hill, TN, February 22, 2005.
  - Buchanan, J R, J N Brogdon, 2004, Comparison of primary and secondary treated wastewater in drip dispersal, National Onsite Wastewater Recycling Association Annual Meeting, Alburquerque, NM, November 7-10, 2004.

Report Follows

Problem and Research Objectives:
The 2002 draft of the U. S. EPA 303(d) list for Tennessee shows 32 stream segments that are impaired due (in part) to failing or leaking septic systems. Systems fail because the design, installation, operation and/or maintenance were not compatible with the limitations of available soil resources. Domestic onsite wastewater treatment systems have two basic functions. The first is to minimize human contact with wastewater and the second is to remove the pollutants from wastewater. Soil is a highly-reactive medium and is used to renovate more than 25% of the domestic wastewater generated in the United States. Life-sustaining elements are cycled by the physical, chemical and biological activities that take place in the soil. These cycling processes allow for the degradation of pollutants contained within domestic wastewater. If onsite renovation systems are not appropriate for the available soil, the result is poorly treated wastewater and the subsequent contaminant loading of surface and ground water reservoirs.

Designers of onsite wastewater management systems need new information about how to renovate wastewater in areas with marginal soil resources. Drip irrigation technology has the potential to optimize the soil's ability to remove pollutants from domestic wastewater. However, the engineering literature provides very little design guidance for using drip irrigation technologies to disperse wastewater into the subsurface soil.

The specific objectives of this project are:

a) Determine whether biomat forms around drip tubing, and to determine whether the quality of the wastewater influences biomat formation around drip tubing.
b) Determine the extent of soil moisture saturation (if any) around the drip tubing.
c) Determine the renovation of the water at various depths below the point of application.
d) Determine the reduction in coliform bacteria as water moves through the soil.
e) Publish the new information generated by this project.

Methods and Accomplishments:
Consolidated Utilities of Rutherford County, Tennessee, has 21 housing developments that utilize decentralized collection, aerobic treatment, and drip dispersal. Crescent Glen subdivision was selected to serve as a wastewater source for this project. Southeastern Environmental Engineers, Inc. is a private utility that maintains several decentralized systems (with aerobic treatment and drip dispersal) in East Tennessee. Jackson Bend subdivision, in Blount County, was selected as a replicate site for this project.

At each location, two separate drip fields have been established. Each field has 1000 feet of drip line installed. The drip lines have been plowed-in 24 inches on center. Specifications for drip line include pressure-compensated emitters rated at approximately 0.6 gph and are spaced 24 inches on-center. At each location, one drip field receives septic tank effluent and the second field receives secondary quality effluent. Approximately 600 gallons of domestic wastewater per day is required at each site - 300 gallons of septic tank effluent and 300 gallons of secondary quality effluent. At each location, an interceptor line has been installed to extract septic tank effluent prior to the aerobic treatment device. This water is transferred to a dose tank used to pressurize the septic tank effluent drip field. Each location already had dose tanks to pressurize their drip fields; we were able to utilize these tanks as a source of secondary quality water.

An intensive soil survey was conducted by registered soil scientists. From that information, the loading rates (gallons per day per square foot) were determined. The Crescent Glen site is being loaded at 0.15 gallons per day per square foot, and the Jackson Bend site is being loaded at 0.20 gallon per day per square foot. All four experimental units are loaded at the design rate each day.

Weather stations have been installed at the sites. Measured weather parameters include solar radiation, precipitation, relative humidity, air temperature, and wind speed. These are the parameters that are required by the Penman-Monteith evapotranspiration estimation model. A crucial component of this effort is being able to create a water balance at each location. By measuring precipitation, soil moisture, and evapotranspiration, deep percolation of effluent can be estimated.

Before installation, each emitter was identified and checked for discharge uniformity. As the dripperlines were installed, the location of each group of emitters was documented for future disinterment.

<u>Installation</u>

Each subdivision has a recirculating sand filter (aerobic treatment) that provides secondary quality effluent. Sump pumps have been installed to intercept wastewater from each subdivision both before and after the aerobic treatment devices. Dose tanks have been installed to receive the intercepted fluid. Each experimental drip field will has individual control stations. Each control station consists of a time-based pump controller, flow meter, filtration system, and a datalogger. Pumps within the dose tanks pressurize the drip fields four times per day.

The dripperlines have been plowed-in using a vibratory plow. Each drip field is composed of 20 parallel rows that are 50 feet long. In each drip field, a portable time domain reflectometry (TDR) probe will be used to measure the volumetric moisture content at nine locations. At each location, the profile moisture content will be measured from the surface to the bedrock in 10-cm intervals. Ceramic cup suction lysimeters will be positioned at 16 locations within each drip field. These lysimeters are used to extract soil-moisture samples.

<u>Data Collection</u>

Every two weeks, water samples will be collected from the lysimeters and dose tanks tanks. These samples will be analyzed for total organic carbon (TOC), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrogenous compounds, and total phosphorus.

On a monthly basis, small segments of dripperline will be removed. The condition of the soil adjacent to the line will be evaluated and the emitters will be tested for any reduction in emission rate. Soil samples will be taken for total coliform and fecal coliform bacteria. Additionally, undisturbed soil cores will be extracted to determine any changes in hydraulic conductivity and redox conditions. A new segment of dripperline will be reinstalled and the soil will be replaced.

<u>Data Analysis</u>

All of these samples will be analyzed to look for differences in soil solution quality and water movement as the two types of effluent pass through the soil profile. The null hypothesis is that the soil will be able to renovate and move the septic tank effluent as well as the secondary-treated effluent. Statistical analysis will be performed on the data to verify this hypothesis.

The Biosystems Engineering and Environmental Science Department has a modern wastewater laboratory. The laboratory has a full-time Research Associate assigned to prepare and analyze wastewater constituents. All assays will follow the current edition of the Standard Methods for the Examination of Water and Wastewater.

Principal Findings and Significance:
It is expected to take several years of operation for the soil system to mature and express differences between the two strengths of wastewater.

To date, the investigators have learned much about the installation of drip tubing for subsurface wastewater application. Much of the equipment that is available for drip irrigation was developed for "clean water" and "crop irrigation." Wastewater, even with aerobic treatment, is not clean. Further, wastewater dispersal systems have to work every day, not just during the growing season. Valves and fittings that work well for clean water will not survive the more aggressive wastewater. As the investigators make these observations, these small "hands-on" discoveries are added to our educational program. The University of Tennessee Center for Decentralized Wastewater Management has conducted four drip design workshops.

Publications and Presentations Resulting from this Research:
Presentations at Conferences

Buchanan, J. R. 2005. Comparison of primary and secondary treated wastewater in drip dispersal. Tennessee Section ASAE Annual Meeting, Crossville, Tennessee, June 16.

Buchanan, J. R. and J. T. Watson. 2005. Subsurface wastewater drip irrigation design workshop. Tennessee Onsite Wastewater Association Annual Meeting, Spring Hill, Tennessee, February 22.

Presentation with Published Abstract

Buchanan, J. R. and J.N. Brogdon. 2004. Comparison of primary and secondary treated wastewater in drip dispersal. National Onsite Wastewater Recycling Association Annual Meeting, Albuquerque Conference Center, Albuquerque, NM, November 7-10.

Future Research and Funding:
This project will last much longer than the original funding period. This funding allowed for the development and construction of the experimental apparatus. Soil and water sampling will take place for at least the next three years. Additional funding will be needed to pay for these analyzes. Potential funding sources are the Tennessee Valley Authority, The Tennessee Department of Environment and Conservation, the Nonpoint Source Program of the Tennessee Department of Agriculture, and the Tennessee Water Resources Research Center.